DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5403

MCHB-TS-OHH

17 May 2005

MEMORANDUM THRU U.S. Army Materiel Command (AMCPE-SG-H/LTC Nasir Siddique), 9301 Chapek Road, Fort Belvoir, VA 22060-5527

FOR Product Manager-Clothing and Individual Equipment (AMSRD-NSC-IP-A/ Mr. Barry Hauck), Program Executive Office-Soldier, Bldg. 325, 10170 Beach Road, Fort Belvoir, VA 22060-5820

SUBJECT: Change to Input to the Safety Confirmation for the Use of Permethrin Treated Army Clothing, Project No. 69-MP-4540-05

1. References. A list of references is provided at Appendix A.

2. Summary.

a. The Army's Health Hazard Assessment (HHA) Program is an Army Medical Department initiative in cooperation with and in support of the Army Materiel Acquisition Decision Process. A specific objective of the program is to enhance Soldier performance and readiness by minimizing the effects of health hazards in the workplace (e.g., field operations, training devices, weapon systems, and clothing/individual equipment). The proponent for the HHA Program is The Surgeon General (TSG); however, TSG has designated the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) as the Lead Agent. The HHA Program supports your compliance with HHA requirements contained in Department of Defense Instruction 5000.2 and Army Regulations (references 1-5).

b. We are providing you a change to our previous memorandum that supported a Safety Confirmation for the Milestone C and type classification for the use of Battledress Uniforms (BDUs) factory-treated with the insect repellent permethrin, as requested (references 6 and 7). The information presented in previous HHA Reports (HHARs) and summarized in reference 6 remains valid except the information that relates to the application of permethrin at the concentration of 0.125 mg/cm^2 and applied only to BDU material. The changes and rationale are presented below.

3. Changes and rationale.

a. Permethrin treatment of Army clothing items. Our previous memorandum only addressed permethrin treatment of the BDU (reference 7). Our memorandum should have addressed the permethrin treatment of all Army clothing items made from essentially the same 50/50 nylon-cotton rip-stop material as the BDU. Many new clothing items [i.e., the Army Combat Uniform (ACU)] are merely redesigns of the older BDU and Desert Battledress Uniform (DCU). It can reasonably be inferred that all of the efficacy and safety data related to the older items apply to new clothing items. Therefore, the change to the permethrin concentration described below applies to the BDU, DCU, ACU, and any other future clothing item that uses the same 50/50 nylon-cotton rip-stop material.

b. The application of permethrin at the concentration of 0.125 mg/cm^2 +/- 10 percent. Our previous HHARs and recent memorandum (reference 7) cited the application of permethrin at the concentration level of 0.125 mg/cm^2. This level was interpreted by the materiel developer and others to be a specific target concentration level for the commercial application of permethrin. It is reasonable to expect a variation in concentration levels that are lower or higher than the specific figure of 0.125 mg/cm^2 during the normal manufacturing process. Therefore, our Center's Toxicity Evaluation Program completed an updated Toxicity Evaluation and concluded that it is acceptable to use a permethrin concentration of 0.125 mg/cm^2 +/- 10 percent (i.e., 0.1125 to 0.1375 mg/cm^2) (reference 8). The Toxicity Evaluation is provided below.

4. Toxicity Evaluation (references 9-13).

a. Background.

(1) The use of permethrin as a treatment for the Army BDU has been evaluated by the Committee on Toxicology (COT) of the National Research Council as well as a number of independent researchers (reference 9). Margins of Safety (MOS) were derived for subchronic toxicity for dermal, ocular, neurotoxicity, hepatotoxicity, immunotoxicity, reproductive and developmental toxicity, genotoxicity, and carcinogenicity.

(2) Various HHARs have been issued by this Center pursuant to permethrin impregnation of uniforms.

(a) 1984: Recommended approval for clothing impregnation with permethrin at a concentration of 0.125 mg/cm^2 and requested additional information on each proposed application process.

(b) 1987: Provided a toxicity review and recommendation for the selection of permethrin containing emulsifiers, and exposure controls for on site impregnation methods and storage of impregnated uniforms.

b. Exposure and toxicity.

(1) The COT's findings/conclusions from reference 9 include:

(a) "The subcommittee analyzed the risk of adverse health effects to Soldiers who wear permethrin-impregnated BDUs and the risk to garment workers who handle permethrin-treated fabric. Based on the review of the toxicity data on permethrin, the subcommittee concludes that soldiers who wear permethrin-impregnated BDUs are unlikely to experience adverse health effects at the suggested permethrin exposure levels (fabric impregnation concentration of 0.125 mg/cm^2). The risk of adverse health effects in garment workers who handle permethrin-impregnated fabric is even smaller because their exposure to permethrin is estimated to be less than that of Soldiers."

(b) "The subcommittee considered the dermal route to be the only significant route of exposure for Soldiers wearing permethrin-impregnated BDUs. Because permethrin is solid at room temperature and has a relatively low vapor pressure, the subcommittee concluded that the inhalation route is probably insignificant and need not be considered. At present, there is no information to indicate that significant exposure to permethrin will occur by any route other than dermal absorption in Soldiers wearing permethrin-impregnated BDUs."

(2) Several conversion factors were used to translate the proposed fabric-impregnation concentration, 0.125 mg/cm^2, to an estimated internal dose for military personnel through dermal absorption. These factors were the time-weighted-average percentage of permethrin remaining in fabric after 50 washings (26 percent), percentage of permethrin migration from fabric to skin (0.49 percent per day), body-contact area (1.5 m^2), dermal absorption rate (2 percent per day), and adult body weight (70 kg).

(3) To adjust for actual exposure conditions, it was assumed that military personnel would wear the permethrin-treated BDUs 18 hours per day for 10 years during a 75-year lifetime. Adjusting for the proportion of lifetime exposure resulted in a calculated average daily lifetime dose of 6.8×10^{-5} mg/kg per day. The only difference between field and non-field military personnel is that field troops apply DEET topically to areas of the skin not normally covered by permethrin-treated BDUs. However, less than 5 percent of the skin would be expected to have overlapping exposure to DEET and permethrin. Thus, no adjustment was made to distinguish between exposure patterns for military field personnel and non-field personnel (reference 9).

(4) A risk assessment for permethrin treatment was developed by COL Steven Berté based on two different absorption rates (2 percent and 7 percent) and differing periods of daily wear (11.5, 16, and 18 hours) (reference 11). The MOS for various endpoints were developed based on information from reference 9. The MOS is the No Observable Effects Level (NOEL) divided by the daily intake. The worst-case scenario is 7 percent absorption with 18 hours per day wear for 10 years (Table 1).

Table 1. 7 Percent Absorption, 18 Hours/Day, 10 Years.

Endpoint	NOEL	MOS
Subchronic Toxicity	5 mg/kg/day (dogs)	20,931
Dermal Toxicity	**8.6 mg/kg/day (Humans)**	**35,002**
Neurotoxicity	200 mg/kg/day (Rats)	837,258
Liver Toxicity	10 mg/kg/day (Rats)	41,863
Reproductive Toxicity	3 mg/kg/day (Mice)	12,559

(5) Appendix B presents an assessment of permethrin risk based on 0.137 mg/cm^2, 7 percent absorption rate, 18 hours per day wear for 20 years of wear (Table 2).

Table 2. 7 Percent Absorption, 18 Hours/Day, 20 Years.

Endpoint	NOEL	MOS
Subchronic Toxicity	5 mg/kg/day (dogs)	9,549
Dermal Toxicity	**8.6 mg/kg/day (Humans)**	**16,424**
Neurotoxicity	200 mg/kg/day (Rats)	381,960
Liver Toxicity	10 mg/kg/day (Rats)	19,098
Reproductive Toxicity	3 mg/kg/day (Mice)	5,729

(6) Conclusion. Based on the above values, it is believed that a 10 percent increase of permethrin concentration from 0.125 mg/cm^2 to 0.137 mg/cm^2 would not cause Soldiers to experience adverse health effects from wear for 18 hours per day for 20 years of wear.

4. Direct inquiries regarding this matter to the HHA Program Manager, MAJ Timothy A. Kluchinsky, Jr. or the HHA Program point of contact (POC), Mr. Robert Gross, at commercial 410-435-2925 or DSN 584-2925. The contributing programs and POCs within USACHPPM include the Toxicity Evaluation Program (Dr. Will McCain,

commercial 410-436-3980 or DSN 584-3980) and the Entomology Program (Mrs. Sandra Evans, commercial 410-436-3613 or DSN 584-3613). Our Occupational Medicine Program provided medical review. Please direct technical questions regarding the Toxicity Evaluation presented in this memorandum to Dr. Will McCain.

FOR THE COMMANDER:

DONNA M. DOGANIERO, CIH
Director, Occupational Health Sciences

CF:
POPM (MCPO-SA)
TRADOC (ATFC-S)
ODCS-G1 (DAPE-MR)
HRC (TAPE-PLC)
FORSCOM (AFMD-PS)
AMEDDC&S (MCCS-FCC-F)

APPENDIX A

References

1. DODI 5000.2, Operation of the Defense Acquisition System, 12 May 03.

2. AR 40-10, Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process, 1 Oct 91.

3. AR 70-1, Army Acquisition Policy, 31 Dec 03.

4. AR 385-16, System Safety Engineering and Management, 2 Nov 01.

5. AR 602-2, Manpower and Personnel Integration (MANPRINT) in the System Acquisition Process, 1 Jun 01.

6. E-mail, PM-CIE, AMSRD-NSC-IP-A /Mr. Barry Hauck, 14 Mar 05, subject: Input to Safety Confirmation (Permethrin).

7. Memorandum, USACHPPM, MCHB-TS-OHH, 16 Aug 04, subject: Input to the Safety Confirmation for the Permethrin Treated Battledress Uniform (BDU), Health Hazard Assessment Program Project No. 69-MP-4540-04.

8. Memorandum, USACHPPM, MCHB-TS-TTE, 16 May 05, subject: Safety of Army Combat Uniform (ACU) Impregnation with Permethrin at a Concentration of 0.137 mg/cm^2.

9. Committee on Toxicology, Health Effects of Permethrin-Treated Army Battle-Dress Uniforms, National Research Council, Washington DC, 94.

10. Schiefer, B., Insect / arthropod repellent protective treatment for military battle dress uniform EPA Reg. No. Basic formulation FE C75, Volume 3: Permethrin quantitative risk assessment, 89.

11. Berté, S., Permethrin Risk Assessment, Colonel, U.S. Army Medical Service Corps, Medical Entomology Consultant, 64 Thomas Johnson Drive, Frederick, MD 21702.

12. Agency for Toxic Substances and Disease Registry, Toxicological Profile for Pyrethrins and Pyrethroids, U.S. Department of Health and Human Services, Public Health Service, Sep03.

13. International Programme on Chemical Safety, Environmental Health Criteria 94: Permethrin, United Nations Environment Programme the International Labour Organisation, and the World Health Organization, Geneva, 90.

APPENDIX B

Permethrin Risk Based on 0.137 mg/cm^2, 7 Percent Absorption Rate and 20 Years of Wear (Adapted from Berté)

Permethrin Risk Assessment

1. Dermal Exposure Assessment			
A. Target Concentration	0.137	mg/sg cm	
B. Adjustment Factor	0.26		Time weighted avg. of permethrin through 50 washes
C. Body Contact Area	1.5	sq meters	
D. Dermal Absorption	7	%/day	Note: EPA assumed 7%; COT used 2% based on CEPA data
E. Migration	0.49	%/day	Fabric to skin; 7 day animal studies. Max rate over first 7 days of wear. Losses beyond 7 days much smaller
F. Body Weight	70	Kg	154 lbs
G. Daily Wear	18	hrs/day	365 days/year
H. Time Worn	20	years	
I. Lifetime	75	years	EPA guidelines
Exposure Dose (ED)	2.62E-03	mg/kg/day	Multiply A*B*C*D*E: Divide by F
Chronic Daily Intake (CDI)	5.24E-04	mg/kg/day	ED X Exposure Factor
2. Carcinogenic Risk	8.38E-06		RISK=(CDI) X (Potentcy Factor)
3. Margin of Safety			NOEL / CDI
Subchronic Toxicity	9549.019		5 mg/kg/day (dogs)
Dermal Toxicity	16424.31		8.6 mg/kg/day (humans)
Neurotoxicity	381960.8		200 mg/kg/day (rats)
Liver Toxicity	19098.04		10 mg/kg/day (rats)
Reproductive Toxicity	5729.411		3 mg/kg/day (mice)

Comments: For calculations, the following actions were performed
1.5 sq m comverted to sq cm (1.5*10,000=15,000)
2% converted to 0.02
0.49% converted to 0.0049
18 hrs converted to days (18/24=0.75)
20 years converted to days (10*365=3650)
75 years converted to days (75*365=27375)